Goddard Procedural Requirements (GPR)

DIRECTIVE NO.	GPR 1860.4C	**APPROVED BY Signature:**	***Original Signed By***
EFFECTIVE DATE:	July 26, 2017	**NAME:**	Richard D. Barney
EXPIRATION DATE:	July 26, 2022	**TITLE:**	Director, Safety and Mission Assurance

COMPLIANCE IS MANDATORY

Responsible Office: 360/Safety Division

Title: Ultraviolet (UV) and High Intensity Light (HIL) Radiation Protection

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PREFACE

P.1 PURPOSE

This directive describes the Goddard Space Flight Center's (GSFC) Radiation Protection Program for Ultraviolet (UV) and High Intensity Light (HIL) radiation. Only UV and HIL radiation is covered in this guide; other types of radiation are covered in other documents.

P.2 APPLICABILITY

a. This directive is applicable to all GSFC personnel, facilities, and activities, including all permanent and temporary sites. This directive shall also apply to all GSFC tenant organizations, contractors, grantees, clubs and other persons operating on GSFC property as required by law and as directed by contractual, grant, and agreement documents.
b. In this directive, all document citations are assumed to be the latest version unless otherwise noted.
c. In this directive, all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms "may" or "can" denote discretionary privilege or permission; "should" denotes a good practice and is recommended but not required; "will" denotes expected outcome; and "are/is" denotes descriptive material.

P.3 AUTHORITY

a. NPR 1800.1, NASA Occupational Health Program Procedures

P.4 APPLICABLE DOCUMENTS AND FORMS

a. American National Standards Institute (ANSI), AWS Z49.1, Safety in Welding and Cutting and Allied Processes
b. American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices (BEIs), latest edition.
c. NPR 1800.1, NASA Occupational Health Program Procedures
d. GSFC Form 23-6UV/HIL, Request for Ionizing Radiation Safety Committee Action – Ultraviolet/High Intensity Light Radiation Source Approval
e. GSFC Form 23-28UV/HIL, Ultraviolet/High Intensity Light Radiation Source Questionnaire

P.5 CANCELLATION

GPR 1860.4B, Ultraviolet and High Intensity Light (UV/HIL) Radiation Protection

P.6 SAFETY

Safety procedures shall be identified for each operation performed at any location descripted in Section P.2 that involves UV or HIL radiation where the operation would cause an individual to receive an exposure to the skin or the eye that would exceed a Threshold Limit Value (TLV) listed in reference b.

P.7 TRAINING

Training requirements are specified in Section 5.

P.8 RECORDS

Record Title	Record Custodian	Retention/Schedule
GSFC Form 23-6UV/HIL Request For Ionizing Radiation Safety Committee Action - Ultraviolet/High Intensity Light Radiation Source Approval	Radiation Protection Office (RPO) keeps original; users maintain duplicate sets.	*NRRS 8/23.5 Cutoff annually. Destroy with concurrence of Center or NASA counsel's office 75 years after cutoff or when no longer needed, whichever is later.
GSFC Form 23-28UV/HIL Request For Ionizing Radiation Safety Committee Action - Ultraviolet/High Intensity Light Radiation Source Approval	RPO	*NRRS 8/23.5
Non-Ionizing Radiation Safety Committee (NIRSC) reviews, and Radiation Protection Office (RPO) area inspection reports, both of which determine that UV/HIL source is potentially hazardous.	RPO	*NRRS 8/23.5
UV or HIL safety plans	RPO	*NRRS 8/23.5

**NRRS 1441.1 - NASA Records Retention Schedules (NRRS 1441.1)*

P.9 MEASUREMENT/VERIFICATION

Metrics will be reported quarterly to the Non-Ionizing Radiation Safety Committee (NIRSC) by the Radiation Safety Officer (RSO) and will include:

a. The number of new UV or HIL operation approvals;
b. The number of employees exposed to harmful UV or HIL; and
c. The number of UV or HIL incidents

PROCEDURES

1.0 GSFC RADIATION PROTECTION PROGRAM

1.1 Introduction

The goal of the GSFC Radiation Protection Program (RPP) is to provide a safe and healthful environment for all persons associated with the Center, including users of UV and HIL radiation sources and devices, Radiation Protection Program Support Staff, students, and visitors. Attainment of this goal requires the cooperation and commitment of all persons involved.

Custodians, approved users, and supervisors are directly responsible for maintaining an atmosphere that promotes full compliance with this directive.

Everyone involved with the use of UV and HIL radiation shall be familiar with the provisions of this directive.

1.2 UV/HIL radiation safety responsibilities

1.2.1 Management

GSFC line management and supervisors have primary responsibility for the safety of personnel working under their jurisdiction and shall:

a. Designate custodians of UV/HIL radiation producing sources and devices; and
b. Ensure that UV/HIL radiation sources and/or devices are used only by individuals approved by the Non-Ionizing Radiation Safety Committee (NIRSC) and that all procedures and requirements are met.

1.2.2 Safety Division

The Safety Division is responsible for oversight of safety programs at GSFC and will support all GSFC organizations in matters involving ionizing radiation, including the NIRSC. The Chief, Safety Division shall ensure a qualified individual is assigned as the Radiation Safety Officer (RSO) and that there are adequate contractual personnel available to support the RPP.

1.2.3 Non-Ionizing Radiation Safety Committee (NIRSC)

The NIRSC is responsible for the development of non-ionizing radiation policies and procedures regarding the safe use of these types of radiation in locations where GSFC operates. The NIRSC will consist of a Chair, RSO, representatives of management, and members from divisions on the Center that

work with or use UV or HIL radiation producing sources and devices, including a representative from Wallops Flight Facility and White Sands Complex. NIRSC shall:

a. Meet at least quarterly, and as often as necessary to accomplish its responsibilities;
b. Ensure that non-ionizing radiation sources used at GSFC or under GSFC programs are managed so as to minimize the health and safety risks to Government and contractor employees and the public;
c. Ensure that GSFC and other Federal regulations, professional standards, and sound health physics practices are met;
d. Evaluate requests for committee action and, if satisfied that safe use will be made of the sources, will approve uses of UV/HIL radiation sources;
e. Ensure that there are responsible users and custodians of UV or HIL radiation;
f. Approve safe operating procedures; and
g. Suspend any approval not in compliance with GSFC's RPP.

1.2.4 Radiation Safety Officer (RSO)

The RSO has administrative responsibility for the Center's RPP and is supported by Radiation Protection Program Support Staff. The RSO shall:

a. Ensure maintenance of records associated with all UV and HIL sources and/or devices reviewed and maintained by the Radiation Protection Office (RPO) located at the Greenbelt campus; and
b. Provide notification to the NASA Senior Environmental Health Officer regarding any unintended personnel UV or HIL exposure.

1.2.5 Radiation Protection Program Support Staff

This staff is made up of personnel provided through a service support contract with qualified health physics personnel positioned at the Greenbelt Radiation Protection Office (RPO) and safety personnel positioned and GSFC sites like Wallops Flight Facility and White Sands Complex. These staff members accomplish many requirements associated with the Radiation Protection Program (i.e. radiation surveys, inspections) and support the RSO to ensure that all uses of UV and HIL sources and devices are done in a safe fashion and meets all federal, state, NASA and local regulations.

The staff is responsible for:

a. Ensuring that all operations using UV/HIL radiation meets the requirements of the GPR and reporting any issues or concerns to the RSO;
b. Recommending approval or disapproval (to the RSO and NIRSC) of applications for the use of UV/HIL radiations;
c. Suspending any activity they determine to be a threat to health or property; and
d. Investigating overexposures, accidents, and other deviations from approved radiation safety practice, and implementing corrective actions as necessary.

1.2.6 Custodians

Custodians are responsible for ensuring that personnel using UV/HIL radiation sources and devices under their authorization are trained in safe-use practices, are familiar with the terms of the authorization

and are complying with Center policies and applicable regulations. The custodian must also be an approved user.

1.2.7 Approved Users

Approved users are employees who have been trained by Custodians to be users of UV or HIL radiation-producing sources and/or devices at the GSFC, and who shall be responsible for knowing and observing all applicable UV/HIL radiation safety regulations.

All unsafe conditions or operations involving UV/HIL radiation sources or devices shall be immediately stopped and reported by the user to their custodian and the RSO. Users should also feel free to raise any safety concerns to their management, the RSO or the NIRSC.

2. HAZARDS ASSOCIATED WITH UV RADIATION

UV radiation is invisible to the eye and is a non-ionizing form of radiation in the 100 nm to 400 nm wavelength region of the electromagnetic spectrum (see fig. 1).

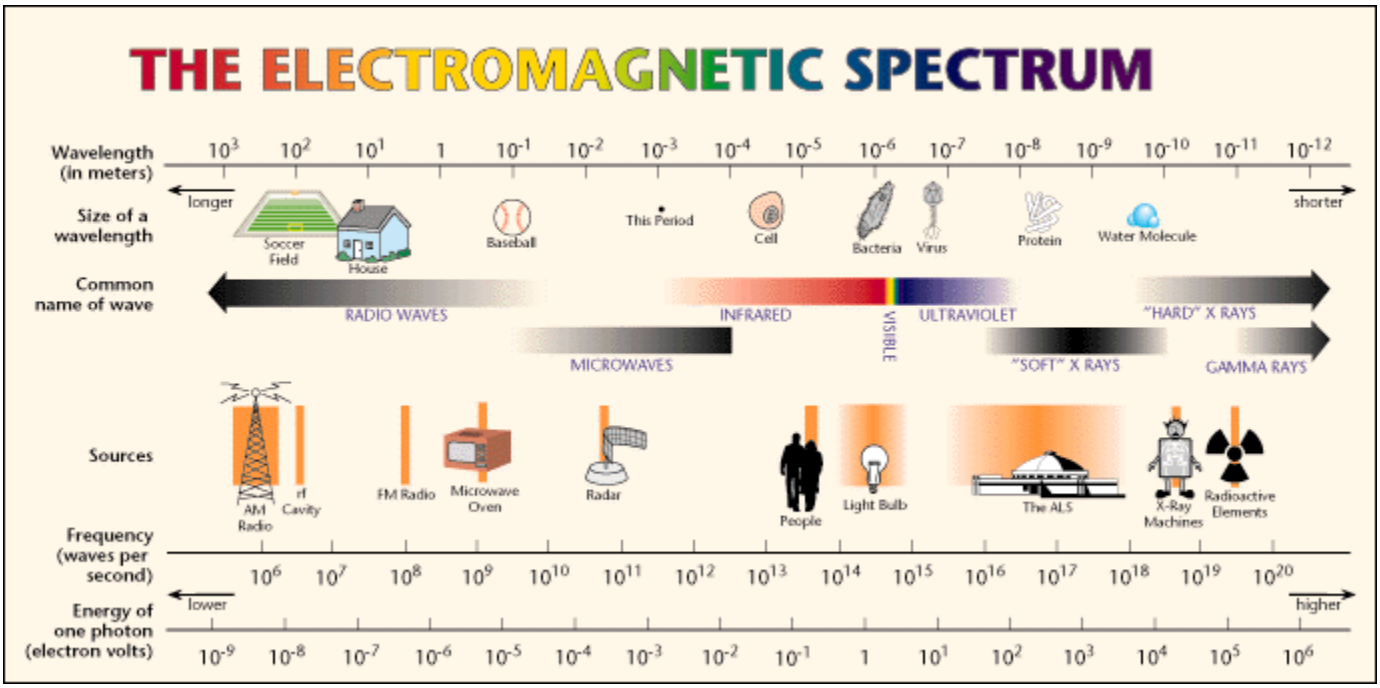

Figure 1. Electromagnetic spectrum

2.1 Eye Hazards

The cornea and lens are the main areas of the eyes affected by UV radiation. The UV wavelength is the determining factor as to which part(s) of the eye may absorb the radiation and suffer biological effects (see table 1).

Table 1. Absorption of UV wavelengths in the Human Eye

Wavelength	Cornea	Aqueous	Lens	Vitreous
100 nm – 280 nm	100%	0	0	0
300 nm	92%	6%	2%	0
320 nm	45%	16%	36%	1%
340 nm	37%	14%	48%	1%
360 nm	34%	12%	52%	2%

2.2 Skin Hazards

UV radiation is a known carcinogen for human skin. Because the biological effects are dependent on the time of exposure, the specific UV wavelength, and the susceptibility of the individual exposed, it is considered prudent to prevent unnecessary skin exposure to UV sources. Elimination of unnecessary skin exposure is advisable since most individuals will receive substantial UV exposure from the sun during normal outdoor activities over a human lifetime.

3. HAZARDS ASSOCIATED WITH HIL RADIATION

HIL sources include compact arc lamps, tungsten-halogen lamps, electronic flash lamps, and other sources of high irradiance. Many HIL sources may also produce UV along with visible and infrared radiation. A "hazardous" HIL-producing device would have the potential for emissions above the Threshold Limit Values listed under Section P.4, b.

4. CONTROL MEASURES

Control measures in this section may not be suitable for all UV/HIL exposure circumstances. Each situation would need to be evaluated so that appropriate control measures can be implemented to prevent overexposure.

4.1 Engineering controls

The preferred control method is the use of engineering control(s) to contain the UV/HIL radiation. Enclosures and interlocks supplied by the manufacturer must be used at all times. UV is easily shielded by opaque materials such as metal, wood, and cardboard. Polycarbonate material is also a good shield. Some types of clear glass may transmit significant amounts of UV radiation and should not be relied on for UV protection unless UV shielding is verified.

4.2 Administrative controls

Procedures should be developed to control and minimize exposure to personnel where engineering controls cannot adequately protect personnel from exposure. Exposure may also be minimized by limiting exposure time and increasing the distance between personnel and the source.

4.2.1 UV/HIL source approval

For all sources of potentially hazardous UV/HIL the custodian of the device will prepare a request for evaluation of the proposed source and its use and submit the request to the RPO for evaluation. The custodian is responsible for the safe use of all UV/HIL emitters under their control.

4.2.2 RPO evaluation requirements

The RPO will review and evaluate custodian requests to determine if there is a potential for hazardous radiation from the device. This evaluation should be based on the TLVs established by the ACGIH (Section P.4, b).

The procedure for the RPO evaluation is as follows:

a. For new sources or devices; the originator will prepare a GSFC Form 23-28UV/HIL describing the source or device.
b. RPO will conduct a hazard evaluation for the source or device.
c. If the RPO evaluation identifies a potential for personnel exposure above the ACGIH TLVs, the custodian of the device will prepare a GSFC Form 23-6UV/HIL and a safety plan that describes the intended use of the source or device along with procedures to be used to minimize personnel exposure and a list of the Users that they have trained.
d. When the RPO receives the request, they will perform a health physics evaluation to determine the adequacy of the equipment, facilities, and location of the particular use of the radiation source or device. Operating procedures and source handling techniques will be discussed and evaluated, including final source disposal options. On the basis of the evaluation, the RPO may impose additional conditions to ensure safe operation. Any additional conditions or explanation of non-approval should accompany the request.

4.2.3 NIRSC review requirements

The NIRSC shall approve or disapprove the request for use of UV/HIL radiation sources and/or devices, and the RPO will notify the originator by providing a copy of the approved or disapproved GSFC Form 23-6HV/HIL. The NIRSC may also impose additional requirements.

4.2.4 Field operations

Field operations using radiation-producing devices differ significantly from indoor laboratory operations. Field stations shall submit the following to the RPO for review:

a. Information concerning equipment design, installation, and interlocks;
b. Information describing how the program will periodically verify proper functioning of interlocks and other protective devices, and measure radiation levels of exposed areas;
c. Maintenance procedures and radiation hazards associated with the equipment; and
d. Safety procedures used during operations and method of enforcement.

The RPO will use the information described above to:

a. Ensure that equipment is properly designed and installed, and that interlocks exist to prevent radiation leaking into unprotected or uncontrolled areas where people could be exposed;
b. Ensure that a satisfactory program exists to periodically verify proper functioning of interlocks and other protective devices, and to measure radiation levels of all exposed areas;
c. Establish training standards for maintenance personnel to ensure that they adequately understand both proper maintenance procedures for the specific equipment, and the radiation hazards associated with that equipment; and
d. Ensure that safety procedures appropriate to each installation are developed and are enforced by station management.

4.3 Personal Protective Equipment (PPE)

If engineering and administrative controls cannot protect personnel from exposure, Personnel Protective Equipment (PPE) shall be used. Commonly used PPE are safety goggles, face shields, long-sleeved, tightly-woven clothing that covers much of the body, and gloves. Any use of PPE has to be included in the safety plan presented by the custodian to the RPO for review.

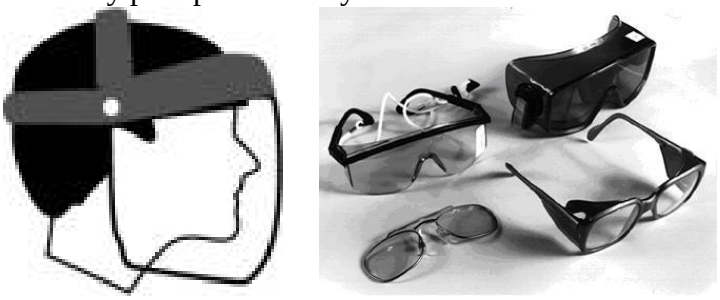

Figure 2. Personal Protective Equipment (PPE)

To protect the human eye from exposure to UV/HIL radiation, all that is usually needed is a pair of polycarbonate safety glasses or a polycarbonate face shield. This protective eyewear shall be worn whenever there is a potential for ongoing UV radiation exposure.

Skin protection is not difficult, as most clothing tends to absorb UV/HIL radiation. Protection of the skin is best achieved through the use of clothing, gloves, and face shields.

4.4 UV/HIL warning signs

The source custodian will be responsible for procuring and posting warning signs where the potential for UV/HIL exposure is possible. Any signs used will be reviewed and approved by the RPO and should meet the standard Occupational Safety and Health Administration (OSHA) or ANSI configurations. Examples are provided below:

Figure 3. Warning Sign Examples

5. TRAINING

Personnel who work with UV/HIL radiation sources will receive safety training by the Custodian responsible for the UV/HIL. This training will include:

a. Information as to the proper eye protection, skin protection, and protective clothing to be used;
b. Instruction on how to recognize the symptoms of eye and skin damage due to UV radiation;
c. Information as to special caution that should be exercised in situations where employees are exposed to other hazards which may be present in addition to, and simultaneously with, UV/HIL radiation;
d. Information about the UV/HIL safety work practices and procedures established for each operation.

Each employee who may be exposed to hazardous UV/HIL shall be apprised of all hazards, relevant symptoms, and precautions concerning exposure.

6. EXPOSURE CONTROL

If an evaluation of a UV/HIL source determines that there is a potential for exposure above the ACGIH limits, the following measures may be used to reduce unnecessary exposures:

a. Where feasible, UV/HIL devices should be located to minimize exposures in areas adjacent to and within the NASA installations. All hazardous areas within the NASA installations should be conspicuously posted with appropriate warning signs. Evaluation of each anticipated operating condition should include consideration and development of procedures for insuring proper placing of warning signs for that operation. Local standard operating procedures should prescribe procedures for the placing of temporary or permanent signs during periods of operations. Signs such as those described in section 4.4 shall be used;
b. Where operation allows, UV/HIL sources should be enclosed in order to minimize the extent of exposure areas, thus reducing unnecessary hazards;
c. The use of barriers and interlocks may be used to prevent ingress by personnel into hazardous areas; and
d. Personal protective equipment (PPE) should be used where necessary, but PPE should not be the option of choice when engineering or administrative controls could limit personal exposure.

7. MEDICAL CONSIDERATIONS

If an employee presents themselves with a medical condition that is being blamed on their exposure to a UV/HIL radiation source they should be referred to the Center's Health Unit (Civil Servants) or their Medical Provider (Contractor). Employees presenting medical conditions should not be returned to work in UV/HIL conditions until cleared by medical personnel.

8. WORK PRACTICES

The following practice will be considered when working with UV/HIL radiation:

a. Worker exposure to UV energy from 200 nm to 400 nm shall be controlled by adherence to the standards, safety plan, or the preventive procedures described in this document, as applicable, which are there to protect against injury from UV energy;
b. Exposure to UV/HIL energy can be controlled by enclosures, shields, protective clothing, gloves, goggles, and/or face shields. Employees shall be protected from eye or skin exposure to UV radiation depending on the sources below:
   (1) Sunlight – Susceptible persons working outside in strong sunlight should be protected. Protective clothing, such as long-sleeved shirts, trousers or skirt, and face and neck protection will normally be adequate. A broad-brimmed hat can afford face and neck protection, as well as a billed-hat or cap or neck shield (if the neck is not protected by hair). Hard hats may have bills or face shields to protect the face, and may have neck shields. Alternatively, barrier creams and goggles or spectacles can achieve face and eye protection.
   (2) Low-intensity UV sources – Examples of sources of low-intensity UV sources are low-pressure mercury-vapor lamps, sunlamps, and black-light lamps. Glass or plastic (1/8 inch thickness or greater) spectacles, goggles, or shields provide adequate eye protection. Lightweight clothing can protect skin, as well as skin creams containing benzophenones or p-aminobenzoic acid, or barrier creams containing titanium dioxide or zinc oxide.
   (3) High-intensity UV sources – Examples of high-intensity UV sources are high-pressure mercury vapor lamps, high-pressure xenon arcs, xenon-mercury arcs, carbon arcs, plasma torches and welding areas.
c. For eye protection, employees shall wear goggles, face shields or masks. The ACGIH guide should be referenced for shade (transmission density) required for this eye protection;
d. Skin shall also be protected. Clothing of densely woven flannelette, poplin or synthetic fabric will give sufficient protection. Face shields can protect facial skin or shades specified in ANSI AWS Z49.1 or by barrier cream containing titanium dioxide or zinc oxide. Because many synthetic clothing fibers can melt or catch fire and thereby cause severe thermal burns, clothing of synthetic fibers should be flame-resistant if operations involve great heat, sparks, or flame; and
e. Welders' helpers and others working nearby may also require protection. Shielding, such as the welders booth, guards against accidental exposure of other people. Reflection from lamp-housings, walls, ceilings and other possible reflective surfaces should be kept to a minimum by coating such surfaces with a pigment-based paint of low UV reflectance. Where such shielding and nonreflective surfaces are not used, welders' helpers and others near the welding operation should wear protective clothing, skin creams, gloves, goggles and/or face shields.

9. ADDITIONAL HAZARDS

The following types of hazards will be prevented:

a. Shock Hazard – There is a shock hazard in some operations involving arcs, because of the high starting voltages required. Wiring connections shall be adequately insulated to prevent shock;
b. Ozone/Explosion Hazard – There shall be adequate ventilation to prevent build-up of ozone and oxides of nitrogen. There may also be an explosion hazard from some UV operations, and the wearing of gloves and face shields will reduce the consequences of an explosion; and
c. Flash or Startle Hazard – The use of flash lamps or high-powered strobes may present a startle hazard to other persons performing detailed tasks in other areas. Custodians of flash lamp systems shall make adjacent workers cognizant of the impending bright flash of these systems. Publishing an announcement with a date and time prior to commencement of flash lamp use may be required.

Appendix A – Definitions

A.1 **Administrative Controls.** Procedures and information provided to personnel for the purpose of reducing exposure to potential hazards and that generally depend on the awareness and participation of personnel for their effectiveness. Examples include warning signs, standard operating procedures (safe work practices), personal protective equipment (PPE), time limits on the duration of exposure (time averaging), and safety training.

A.2 **Approved User.** Any employee or contractor who has been trained by the Custodian to use specific sources and devices that emit UV/HIL radiation for specific purposes and at specific locations.

A.3 **Custodian.** An approved user who has been designated by the appropriate management and approved by the NIRSC to assume the responsibility of accountability for specific sources of UV/HIL radiation. The Custodian is not an equipment manager.

A.4 **Engineering Controls.** Controls and performance guidelines to reduce exposures as implemented by use of specific types of equipment, such as interlocks, protective housings, man-proof barriers, or the configuration of equipment at a site. Engineering controls do not depend on the awareness of personnel for their effectiveness in reducing exposure.

A.5 **Non-Ionizing Radiation.** Any type of electromagnetic radiation that does not carry enough energy to ionize living material, that is, to completely remove an electron from an atom or molecule. Instead of producing charged ions when passing through matter, the electromagnetic radiation has sufficient energy only for excitation, the movement of an electron to a higher energy state.

A.6 **Personal Protective Equipment (PPE).** Equipment designed to protect personnel from serious workplace injuries or illnesses resulting from exposure to UV/HIL radiation.

Appendix B – Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
BEI	Biological Exposure Index
GPR	Goddard Procedural Requirement
GSFC	Goddard Space Flight Center
HIL	High Intensity Light
NIRSC	Non-Ionizing Radiation Safety Committee
NPR	NASA Procedural Requirements
NRRS	NASA Records Retention Schedules
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
RPO	Radiation Protection Office
RPP	Radiation Protection Program
RSO	Radiation Safety Officer
TLV	Threshold Limit Values
UV	Ultraviolet

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	01/26/2005	Initial Release
A	04/02/2010	Administratively Revised to update the Responsible Office Code, Organization Title and organization name within the document. Administratively extended for 1 year from original expiration date.
B	05/13/2011	Updated to make changes in regulations and organized GPR per the most recent GSFC GPR template. Table of Contents was added with each section numbered. Section 1: Established the Non-Ionizing Radiation Safety Committee (NIRSC) and clarified their roles and responsibilities.
	03/18/2016	Administratively changed to update the Responsible Office Code and organization name throughout the document. Administratively extended for 1 year.
C	07/26/2017	Revisions to the document were made to bring it up-to-date with current procedures and practices.